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THE A-10 AND DESIGN-TO-COST: HOW WELL DID IT WORK?

BY
ROGER E. CARLETON, Major, USAF

A RESEARCH STUDY SUBMITTED TO THE AIR FORCE FACULTY

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AIR FORCE SECTION

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(11) May 1979

Barry E. Bridger
Major, USAF
Research Advisor

U.S. ARMY COMMAND AND GENERAL STAFF COLLEGE
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ABSTRACT

As a weapons system procurement process Design-to-Cost is supposed to achieve its program objectives within cost constraints by trading off among cost - schedule - performance to achieve the optimum solution. The underlying assumption of Design-to-Cost presupposes that the stated cost goal is the correct price for the desired military capability. In the case of the A-10 five pilot identified deficiencies are examined in detail to reveal the fallacy of this assumption. Correction of these deficiencies is required in order to give the A-10 a significant military capability in a postulated Central European scenario. The costs associated with correction of these five deficiencies and their retrofit modification schedules are submitted to show Design-to-Cost lack of responsiveness. This lack of responsiveness increases total program costs thereby raising the price required for the desired military capability. Four recommendations are submitted to improve this lack of responsiveness.

PROFESSIONAL BACKGROUND

The author possesses a broad tactical background. He has flown the F-100, F-111A, A-37B, and the YA-10/A-10A. He has served a one year ASTRA tour in Air Force Legislative Liason. From October 1974 until June 1978 his duties permitted him to become extremely knowledgeable about all aspects of the A-10 program. During this period he was a member of the Initial and Follow-On Operational Test and Evaluation teams responsible for testing and reporting the military utility and operational effectiveness of the aircraft. In May 1977 he became the Assistant Operations Officer of the first A-10 training squadron in Tactical Air Command. He remained in that position until attending the U.S. Army Command and General Staff College in June 1978. He holds a B.S. degree in Engineering Science from the U.S. Air Force Academy and a M.S. degree in Astronautics from Purdue University.

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EXECUTIVE SUMMARY

TITLE: THE A-10 AND DESIGN-TO-COST: HOW WELL DID IT WORK

AUTHOR: MAJOR ROGER E. CARLETON

ADVISOR: MAJOR BARRY B. BRIDGER USACGSC/ATSW-AF

I. Purpose: To examine the responsiveness of the Design-to-Cost (DTC) procurement system used in acquiring the A-10 Close Air Support aircraft from the perspective of the pilot.

II. Problem; As a weapons system procurement process DTC is supposed to achieve its program objectives within cost constraints by trading off among cost - schedule - performance to achieve the optimum solution. The underlying assumption of DTC presupposes that the stated cost goal is the correct price for the desired military capability. This assumption is the major problem of Design-to-Cost. If systems do not meet contractual design specifications during the course of testing, they are upgraded until reasonable performance levels are attained. But costs associated with modifying systems to meet stated operational requirements have a far greater impact on program costs than those which fail to meet design specifications. If the DTC procurement system can become more responsive to operator identified deficiencies then costs associated with retrofit modifications can be reduced which, in turn, reduces life cycle costs and enhances fleet standardization.

III. Data; Five pilot identified deficiencies are examined as they were discovered during different phases of operational test and evaluation. Each of these five deficiencies has an impact on the military utility and operational effectiveness of the A-10 in a postulated Central European scenario. The interface among the Air Force Test and Evaluation Center, the developing command (Air Force Systems Command), and the using command (Tactical Air Command) is examined to show how pilot reports reach senior Air Force managers. Retrofit modification schedules for these five systems depict the unresponsiveness of the present Design-to-Cost system. Increases in program costs due to these modifications prove that lack of responsiveness contributes significantly to additional program costs.

IV. Conclusions: Based upon an analysis of five deficiencies and their costs for correction, the author concludes that the present DTC system is not responsive to operator inputs. Additionally, he finds that an ad hoc Joint Operational Technical Review (JOTR) to determine ways to hold down program costs did more harm than good.

V. Recommendations: The Air Force should abolish the concept of JOTRs. The using command should become more involved with the development program at the earliest possible date. Finally, a periodic meeting should be held between pilots, Air Force Test and Evaluation Center representatives, staff officers from the using command headquarters, and senior program managers to discuss problem areas thereby increasing direct communication at all levels.

CHAPTER I

INTRODUCTION

> Technology, per se, does not equate to military power. Rather the real significance of technology to the balance of military power lies in the ability of each nation to transform its scientific discoveries and engineering breakthroughs into military capability - in the form of equipment which enhances or multiplies force effectiveness and which can be deployed in militarily significant numbers ...
>
> Dr. Malcom R. Currie, OSDDDR&E[1]

This quote by Dr. Currie in support of FY1978 Research Development Test and Evaluation (RDT&E) expenditures for the Department of Defense (DoD) shows the relationship between technology and military power. The key thoughts focus on improved capabilities and militarily significant numbers. But significant numbers must be attained within the context of dollar costs which have risen dramatically over the last few decades. In fact, the real (adjusted for inflation) cost of producing a single tactical fighter has doubled on the average once every four years over the past three decades.[2]

Discounting inflation, these cost growths can be tied to mission priorities and design philosophy.[3] Mission priorities are those tasks which must be carried out by tactical air forces and in their proper order. For example, Air Superiority, Interdiction, and Close Air Support (CAS) are three ordered tasks performed by our tactical air forces. On the other hand, design philosophy dictates the kind of aircraft built to accomplish these tasks. Although these issues are of fundamental importance, the procurement process itself can have a large influence on the ultimate cost of an aircraft.

DoD procurement methods have received intense criticism since the early 1970's because billions of dollars were spent for equipment which was never produced in sufficient quantity. Air Force procurement programs which fell into this category were the C-5 cargo aircraft and the TFX (F-111) tactical fighter.[4] As Senator William Proxmire, a vocal critic of military waste, has stated:[5]

> The frightening truth about our weapons procurement process is that one can search in vain for a weapon that was produced on time, worked according to specifications, and did not exceed the estimated cost.

Following the criticism associated with Total Package Procurement for the C-5 and F-111, it was logical that a newer, more innovative procurement process would be used for the development and production of Air Force aircraft. In fact, the A-X aircraft (designed strictly for CAS missions) was the first to be procured under this revolutionary technique known as Design-To-Cost (DTC).

DTC differs greatly from Total Package Procurement (TPP). TPP is a process wherein development and production items are placed with one contractor on a fixed price contract.[6] Thus, TPP may allow the contractor to "buy in" for a conservative estimate, justify cost increases over the life of the program based upon a weapon system's performance specifications, and then pass these costs on to the government. DTC as defined by DoD Directive 5000.28 is as follows:[7]

> A management concept wherein rigorous cost goals are established during development, and the control of systems costs (acquisition, operating, and support) to these goals

is achieved by practical trade-offs between operational capability, performance, cost, and schedule. Cost, as a key design parameter, is addressed on a continuing basis and as an inherent part of the development and production process.

If successful, a DTC program can achieve two objectives. First, cost becomes a parameter equal in importance to either performance or the schedule. Second, to stay within stated cost goals the program manager must trade-off among cost - performance - schedule to achieve the optimum solution.

Implicit in attaining these two objectives is the fact that DTC will probably require more development time to achieve the necessary trade-offs. For example, both the A-X and F-15 were undergoing development at the same time. The A-X program was contracted under DTC while the F-15 was not. Additionally, the A-X program used a Fly-Before-Buy concept wherein the two A-X contractors (A-9: Northrop Corporation, A-10: Fairchild-Republic Corporation) each built and flew two prototype aircraft. (Fly-Before-Buy is a technique which provides DoD an estimate of performance as well as unit production costs.[9]) The A-10 first flew in May 1972 and the F-15 in June 1972. Because of the different procurement philosophies used, the introduction of the F-15 into the operational inventory is roughly two years ahead of the A-10.

Rather than concentrate on the advantages or disadvantages of different procurement methods, this paper will attempt to focus on the major problem of DTC. Namely, is the established DTC goal the correct price for the desired military capability? Another way of stating the same proble is to see if the procurement process is responsive to changes which may cause an increase in dollar costs but are absolutely essential to successful mission accomplishment. Perceptions of the same problem may be and often are different. While Defense Systems Acquisition Review Council (DSARC) members and Congressional Committees are ultimately concerned with dollar costs, the pilots responsible for testing the weapon system are more concerned with its military capability.

Statement of Purpose

The purpose of this paper will be to examine the responsiveness of the DTC procurement system from the perspective of the pilot. Specifically, the A-10 CAS aircraft will be the vehicle to facilitate this examination. It is the contention of the author that changes are required in order to make DTC more responsive to operator identified deficiencies. In turn, responsive changes can result in reduced costs for retrofit modifications, a decrease in life cycle costs, an increase in fleet standardization, and an overall increase in combat capability.

CHAPTER II

THE PROBLEM

Every new aircraft entering the operational inventory is plagued with certain problems which time, money, and engineering expertise can overcome. Rather than focus on all the problems - maintenance, operations, and support - associated with the A-10, this paper will concentrate on five pilot identified deficiencies which require correction if the aircraft is to possess a significant military capability. The important point is that these deficiencies were identified early in operational testing but their fixes were, and are, being implemented far downstream in the A-10 production run.

A Definition

Other than dollar costs which are both measurable and quantifiable, the measurement of "significant military capability" poses problems for operations analysts. What might be significant to one is of no consequence to another. For the purpose of this paper "significant military capability" will be defined to be that inherent capability which increases the probability of of a first pass successful attack against front line Soviet/ Warsaw Pact Motorized Rifle or Tank Divisions in a Central European scenario during the winter months. This definition is highly restrictive because it requires the A-10 pilot to expend ordnance on the first pass thereby minimizing exposure to enemy weapons. It also postulates a worst case scenario in terms of density of surface-to-air weapons. Finally, the limitation of winter portends poor weather which decreases the pilot's ability to successfully navigate to an area and locate valid targets.

An Example

Other than the Paris or Farnborough Airshows, the first tactical introduction of the A-10 into the European theater occurred in September 1977 when six A-10's from the 355th Tactical Fighter Wing at Davis-Monthan AFB, Arizona deployed to West Germany to participate in firepower demonstrations and joint US Army - US Air Force close air support exercises.

On the positive side, this deployment showed the ability of the aircraft to generate very high sortie rates compared to in-place USAFE or NATO aircraft.[10] Additionally, the A-10 proved to all observers that it was, indeed, a different breed. As such, tactics and rules applicable to F-4's were not entirely valid for the A-10.

On the negative side, the deployment highlighted certain deficiencies which the A-10 pilots felt must be corrected to provide a minimum acceptable level of military capability. These deficiencies were noted in Donald Brown's Aviation Week and Space Technology (AW&ST) article "Pilot's Stress Navaid Requirement", published September 19, 1977. In this article the A-10 pilots were adamant in the need for a self-contained Inertial Navigation System (INS) and a better Heads-Up Display (HUD) unit which increases forward transmissibility.[11] (Transmissibility simply means that more light rays are reaching the pilot's eyes after passing through the front windscreen and HUD combining glasses. The more light rays that enter, the clearer the "real world" appears to the pilot and it becomes easier to detect hard to see targets.) As the article states, pilots had difficulty acquiring targets because of reduced inflight visibility associated with European weather and the dark banding in the HUD which further aggravated either target detection or accurate ordnance delivery. The fact that this deployment took place in September rather than in weather associated with the winter months deserves comment. As Table 1 shows, the weather can be significantly worse beginning in October.

Table 1

Average Ceiling/Visibility in Germany[12]
(percent of days when these conditions occur)

	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Nov	Dec Only
Ceiling less than 1000' and/or visibility less than 3 miles (< 1000/3)	28	8	11	35	42
Ceiling and vis greater than 1000/3 but less than 3000/3 (1000/3<ceil/vis < 3000/3)	27	16	15	27	29
Ceiling and vis greater than 3000/3 (> 3000/3)	45	76	74	38	29

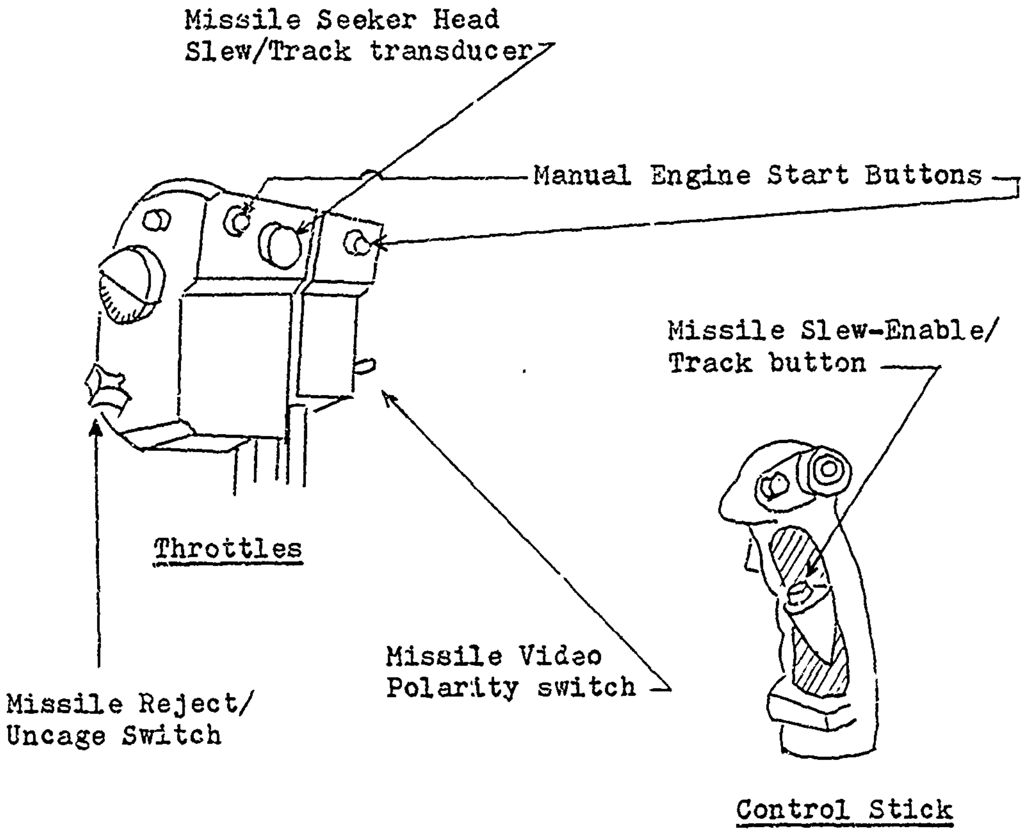
Table 1 shows that navigation and target acquisition may become more difficult in winter months due to deteriorating weather conditions.

The pilots also experienced difficulty in attaining lock-ons with the AGM-65A Maverick missile. This missile is guided to the target by an electo-optical seeker head which requires a definite target-to-background contrast to achieve and maintain lock-on. Though not mentioned in the AW&ST article, the A-10's were operating with a Maverick switchology design deficiency that could affect lock-on unless the pilot was extremely conscious of his actions. Figure 1 depicts the cockpit controls used to slew the missile cursors to a target and then command lock-on. The design deficiency was that there were two ways to command lock-on. First, the pilot could use only the Missile Seeker Head Slew/Track transducer on the forward portion of the right throttle. Depressing this transducer enabled slew and when released it commanded lock-on to the seeker head. The second method involved both the control stick and the throttle switches. The pilot would depress the Missile Slew-Enable/Track button on the control stick and then slew the missile cursors to the target by using only the slew function of the Seeker Head Slew/Track transducer on the right throttle. When the cursors were over the intended target, the pilot removed his right thumb from the control stick Slew-Enable/Track button to command lock-on. If the pilot was not extremely careful when using this second method he could impart too much pressure to the force transducer while slewing thereby preventing lock-on when he released his right thumb. If such an action did occur, the missile could not lock-on to the designated target.

There are two other deficiencies not covered in this AW&ST article but common knowledge to A-10 pilots. First is the poor ability of the Stability Augmentation System (SAS) to dampen aircraft oscillations after high G roll-ins on the target. The extra time required for the pipper (the aiming symbol in

Figure 1

A-10 Maverick Missile Switchology



the HUD) to settle down translates into into longer wings level time, increased exposure to enemy defenses, decreased slant range to the target, and decreased survivability. Second is the absence of an internal flare/chaff carrying and dispensing capability. The six A-10's on this deployment would have to carry these countermeasures on an external pylon if they had to fly a combat mission. Unfortunately, logic in the Armament Control Panel precludes arming more than one particular type of ordnance at a time. This means that if an A-10 pilot was suddenly placed in imminent danger of a surface-to-air missile (SAM) attack while in the act of firing a Maverick missile or releasing ordnance, he would have no option but to abort his pass by diving back to the relative safety of lower altitudes. To dispense flares or chaff, the pilot would have to deactivate the missile/ordnance stations and then select the flare/chaff station. Precious seconds are lost before dispensing active countermeasures which might spell the difference between survival or destruction.

Summary

The five A-10 systems that can provide a significant military capability in the postulated environment have been outlined in the preceeding discussion concerning CORONET BANTAM, the A-10 deployment to Europe in September 1977. These five systems - Stability Augmentation System, Heads-Up Display, Flare/Chaff, Maverick Slew/Track, and Inertial Navigation System - were all identified during operational testing and evaluation as deficiencies which required correction. Each of these five systems now has an identified fix which will correct the deficiency at some point in the production of 733 A-10's.

To illustrate how and when these five deficiencies were first brought to the attention of the A-10 Program Manager and Tactical Air Command (the using command), it is necessary to examine the organization and charter of operational testing and evaluation (OT&E). (Note: OT&E encompasses both Initial and Follow-on testing. It is a generic term which describes testing related to the intended operational use of the aircraft.)

CHAPTER III

THE SYSTEMS ACQUISITION PROCESS

The DoD systems acquisition process is governed primarily by two directives: DoDD 5000.1, "Major Systems Acquisitions", and DoDD 5000.2, "Major Systems Acquisitions Process". The first directive defines basic policy while the second directive outlines the review process used by DoD management in evaluating the progress of a weapon system until it is deployed.[13] Table 2 depicts the phases and milestones of the overall systems acquisition process.

Table 2

DoD Systems Acquisition Process

Phases:	Conceptual	Validation	Full Scale Engineering Development	Full Scale Production & Deployment
Milestones:	0	I	II	III

Table 3 is merely Table 2 combined with various phases of A-10 testing. For purpose of clarity only phases of OT&E are depicted. Development Test and Evaluation (DT&E) is also being performed concurrently with OT&E.

Table 3

A-10 Operational Test and Evaluation

Conceptual	Validation	Full Scale Engineering Development	Full Scale Production & Deployment
	IOT&E Phase 1	IOT&E Phase 2	FOT&E Phase 1

There are many other sub-categories within each phase that are beyond the scope of this paper. Of particular importance to the eventual success or failure of a program are the various milestones. Milestone 0 previously began with approval of a Required Operational Capability (ROC) by the Secretary of Defense. The ROC has lately been replaced by a MENS (Mission Element Need Statement).

A Decision Coordinating Paper (DCP) is required at each milestone. It is prepared by the Service tasked with the responsibility for system development. Therefore, the DCP becomes the main document for recording program information developed during a preceeding phase as well as documentation for the decision to proceed to the next phase.[14] The DCP must be approved by the Secretary of Defense.

The decisions and recommendations found in the DCP are a principal function of the Defense Systems Acquisition Review Council. A DSARC review at the end of each milestone permits DoD management to examine all aspects of the program to include cost, schedule, technical risk, logistics, maintenance, and performance. Results obtained from testing the weapon system are an important input to the DSARC process. The A-X program testing during the Validation phase prior to Milestone II was slightly different because it featured a Competitive Prototype Phase between the two competing systems - the A-9 and A-10.

DSARC III (the DSARC occurring at Milestone III) is the major DSARC decision because it is the last hurdle before a weapon system enters full scale production. In the A-10 program the results of Phase II Initial Operational Test and Evaluation (IOT&E) were made available to the DoD managers through the Air Force Test and Evaluation Center (AFTEC) which functioned as the Air Force's independent reporting agency.

THE ROLE OF AFTEC

In response to Congressional criticism AFTEC was created as an "independent management agency for the operational test and evaluation of emerging Air Force weapon systems."[15] The charter of AFTEC is to test these systems in an operational environment to see how well they perform their intended mission. Independence is assured by having AFTEC report directly to the Air Force Chief of Staff rather than reporting through the developing command (Air Force Systems Command) or the using command.

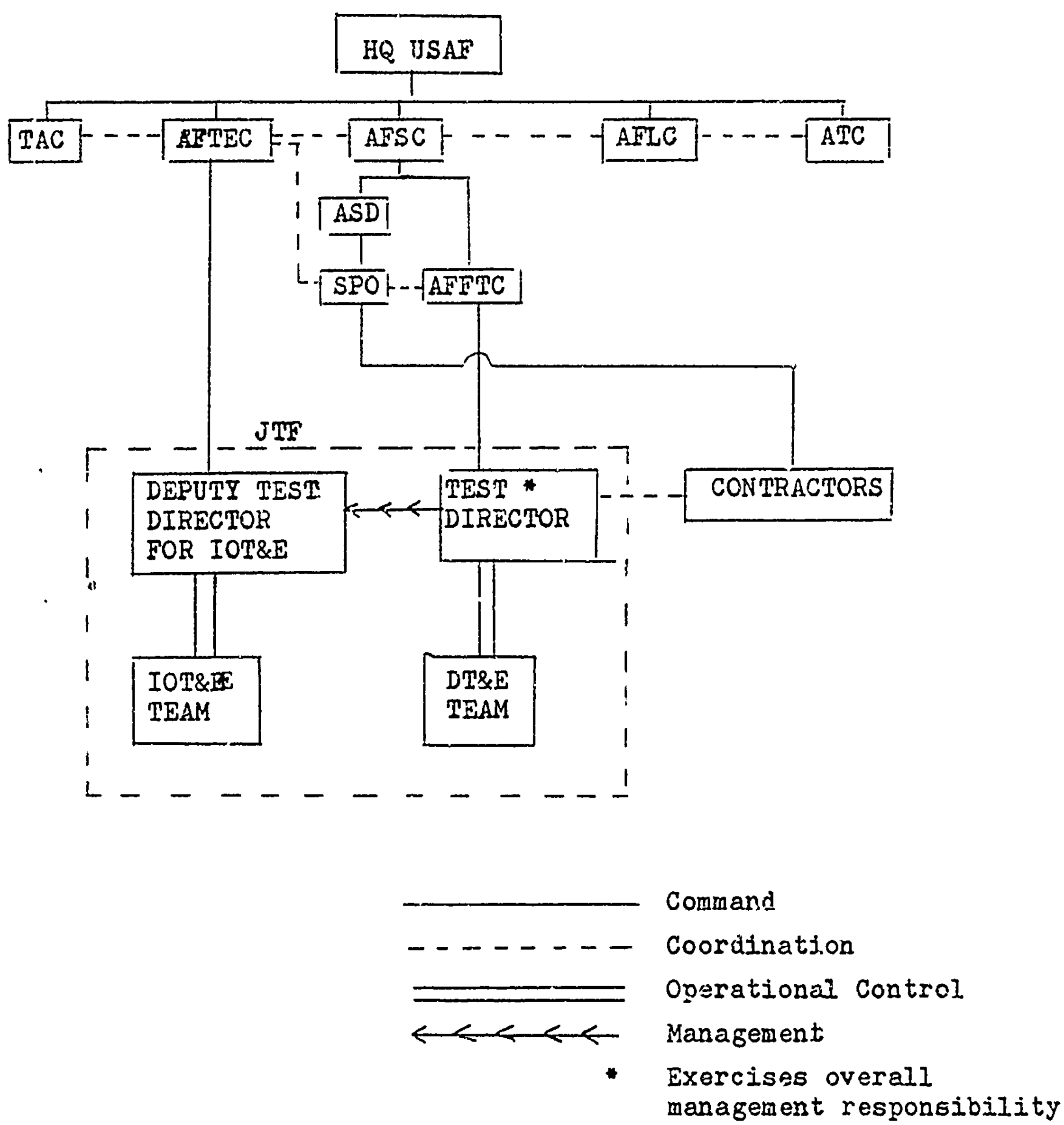
AFTEC does not possess sufficient people to perform the actual testing. Instead, AFTEC provided an O-6 Test Director to manage IOT&E. AFTEC assumed operational control of the Tactical Air Command (TAC) personnel assigned to the A-10 Joint Test Force - five pilots and some seventy-two maintenance specialists. Figure 2 shows the command relationship that existed throughout IOT&E. Because Follow-on Test and Evaluation (FOT&E) was conducted at the first operational base, the only changes to Figure 2 to depict this command relationship would be to sever the Test Director and Contractor links and disband the Joint Test Force. AFTEC was the single manager for Phase I FOT&E.

Testing

A-10 OT&E performed under AFTEC prior to DSARC III consisted of two phases. (Table 3, page 12) Phase I IOT&E assessed the

Figure 2

Command Relationship[16]



operational suitability of the A-10 through participation in Phase I DT&E tests with the YA-10 (prototype) and early Phase II DT&E tests with the A-10A pre-production aircraft.[17] Phase II IOT&E testing was conducted from March 1975 through March 1976 using six pre-production aircraft and three production A-10's before the latter were accepted by TAC.[18]

Phase I IOT&E Testing

Two of the five problems to be discussed surfaced during this phase: SAS/Aileron Rudder Interconnect (ARI) and the HUD field-of-view (FOV) along with the lack of HUD filters for night operations. The A-10 SAS is basically an open loop system. For each 'X' amount of aileron input a certain 'Y' amount of rudder deflection will automatically be commanded to maintain coordinated flight. Changes to the SAS/ARI during this phase resulted in an overall excellent rating for the system. Unfortunately, changes from the prototype to the pre-production A-10 involved such major changes as moving the main wing two inches forward and the main landing gear four inches forward.[19] These technical changes to the aircraft rendered the previous SAS/ARI optimization useless.

The IOT&E test team's first look at the single combiner HUD was a major cause for concern. This HUD was unuseable because of the restricted FOV. The pilot had to bend and contort his body forward in order to see the pipper for strafing attacks. Fortunately, Kaiser Aerospace and Electronics was awarded the HUD contract after six single-combiner units were built by another contractor. Kaiser introduced the dual-combiner HUD which reduced the magnitude of the FOV problem but introduced another pilot irritant of dark banding within the HUD. This dark band was a result of three different coatings applied to the HUD combining glasses to project the symbology to the pilot. Unfortunately, the pilot now viewed the outside world through three different intensity settings when looking through the HUD.

Phase II IOT&E Testing

SAS: After contractor re-engineering an Air Force Preliminary Evaluation (i.e. an acceptance profile) was conducted using three A-10 pilots. One of these pilots was the most experienced air-to-ground IOT&E pilot. Handling qualities of this SAS were judged according to the Cooper-Harper Rating Scale. (Appendix A) The IOT&E pilot awarded the SAS a Cooper-Harper rating of three while the other two test pilots awarded it a much lower rating. Even the Air Force Flight Test Center formal report stated this SAS still exhibited many deficiencies:[20]

> Analysis of the data gathered during this Air Force Preliminary Evaluation clearly demonstrate that the largest tracking error was consistently in azimuth, which indicated deficiencies with lateral directional aircraft/SAS/pilot characteristics.

Program managers at the A-10 Systems Program Office (SPO) accepted the rating of the lone IOT&E pilot as final and discontinued further SAS optimization. It appears as if one pilot's opinion/acceptance of a system was a sufficient data base upon which to formulate a decision, especially if continuing optimization could result in increased program costs.

HUD: The final version of the Kaiser production HUD saw the dual-combiner assembly lowered one-half inch to provide adequate windscreen/bird resistance. (The windscreen is designed to sag upon impact. If it contacts the HUD combining glass the front windscreen might rupture.)[21] This lowering of the HUD to satisfy a safety specification caused an additional one inch down and three inches forward head motion to see the minus 41 milliradian setting used for strafing attacks. Lack of filters for night operations and banding were still present. This HUD was rated operationally unsuitable at the end of Phase II IOT&E testing.[22]

Maverick Slew/Track: (reference Figure 1, page 9) The original missile Slew/Track control functions were to be incorporated in a single button on the right throttle. The F-15 had used this identical control mechanism for radar cursor positioning. The F-15 eventually discarded this control function because the combined functions of slew and track caused lock-on problems. This problem was that during release the cursors would often jump off target due to lateral force imparted to the transducer. Based upon the F-15 experience a separate Slew-Enable button was incorporated on the control stick.

IOT&E pilots evaluated both switchologies during captive Maverick flights and unanimously agreed that the function of the transducer on the right throttle should be slew only. The pilot's actions for launch would be to depress Slew-Enable/Track on the control stick, slew the missile cursors with the force transducer on the right throttle, and then release the control stick Slew-Enable/Track button to command lock-on while holding the cursors steady. This method was extremely effective for multiple lock-ons on a single pass as well as operating in turbulent conditions. The IOT&E

position was that this switchology was definitely the preferred alternative.

Flare/Chaff: The Phase II IOT&E report identified external carriage of flares/chaff as a critical operational deficiency because neither could be expended if another ordnance station had been selected on the Armament Control Panel.[23]

INS: Although the original A-10 specification did not address the necessity for an Inertial Navigation System, the IOT&E pilots felt it was so important that they identified as a critical operational deficiency the fact the A-10 was equipped only with a TACAN for navigation.[24] Since Phase II testing was conducted in a desert environment where neither visibility nor prominent landmarks were a problem, the need for an INS constituted nothing more than the opinion of pilots tasked to identify capabilities and deficiencies.

DSARC III Results

In addition to the five deficiencies thus outlined perhaps the major critical operational deficiency was the marginal single engine performance of the A-10. Related to single engine performance was the poor performance in certain aircraft/ordnance configurations.[25] This failure to meet performance goals began during the prototype phase and continued with the introduction of the production A-10. Table 4 shows the YA-10 performance summary.

The A-10A Specifications in Table 4 were predicated upon extensive drag reduction engineering by the contractor to upgrade aircraft performance. Fairchild-Republic further stated

Table 4

YA-10 Performance Summary[26]

	AF Goal	YA-10	A-10A Specification
Forward Airstrip Performance			
Take-off(ft)	1000	1240	1050
Landing(ft)	1000	1050	1050
Speed KTAS			
Cruise at 5000 ft	300	281	325
Max at Sea Level	400	350	390

"the total reduction in drag and the increase in engine thrust to production guarantee levels will be reflected in an 11% increase in the rate of climb and acceleration, a 15% increase in sustained G capability, and a 40 knot increase in maximum velocity."[27]

As is often the case, the performance results did not match the optimistic predictions of the engineers. The dilemma facing the DoD was whether or not to proceed with Full Scale Production in the light of these test results. In the case of the A-10 the highly successful test of the GAU-8/A 30 millimeter gun against representative armored targets evidently influenced the decisionmakers to proceed with production. The capability of the gun was seen as an effective counter to the Soviet/Warsaw Pact armored superiority within NATO. The A-10 had passed the last hurdle based upon its demonstrated ability to defeat tanks with its 30 millimeter gun. The identified operational deficiencies associated with navigating to an area, visually locating a target, employing flares or chaff as necessary, and maneuvering the aircraft to attain a first pass kill were downplayed in view of the gun's tremendous capability. In fact a formal DSARC was never held. Instead, the DCP was circulated for signature and approval.

CHAPTER IV

THE A-10 SINCE DSARC III

The DCP approving entry into Full Scale Production was signed in late 1975. IOT&E Phase II testing continued at Edwards AFB until March 1976. At that time the AFTEC A-10 Test Director and two of the five IOT&E pilots were transferred to Davis-Monthan AFB, Arizona to train the initial cadre of TAC pilots and then commence Follow On Test and Evaluation (FOT&E) Phase I testing in August 1976. It was during FOT&E that previously identified deficiencies began to be addressed in a meaningful manner.

This positive change can be attributed to the management tool used by TAC Headquarters. The senior TAC pilot on the IOT&E Test Team was assigned to the job of Director, Systems Management Office, A-10 (SMO-10). SMO-10 also had a small staff dedicated only to A-10 matters. Organizatioally, SMO-10 was under the TAC Deputy for Requirements and co-located at Langley AFB, Virginia. This location permitted a steady dialogue with other TAC agencies involved with the introduction and continuing support of the A-10. SMO-10 existed for two years beginning in March 1976. During these two years more progress was made in solving identified problems/deficiencies than ever before.

FOT&E Test Schedule

FOT&E testing began 26 August 1976 and ended 1 May 1977 with the completion of the final test report. The overall test purpose was to verify the operational effectiveness, military utility, and operational suitability of the production A-10 in performing the Close Air Support mission.[28] In addition, the A-10s assigned to the FOT&E team conducted a sortie surge demonstration at Gila Bend Auxiallary Air Field, Arizona where two A-10s each flew 17 sorties in one eleven hour period. Three A-10s and four pilots participated in DoD directed testing of the AGM-65D Imaging Infrared (IIR) Maverick missile at Ft. Polk, Louisiana. Even though these two tests were not part of the original test plan, they were managed by AFTEC and data obtained was used in preparing the final report.

During the time that FOT&E was in existence, TAC began receiving airplanes which had been modified by decisions reached in May 1975 by a group known as the Joint Operational Technical Review.(JOTR).

JOINT OPERATIONAL TECHNICAL REVIEW

From a pilot's point of view, one of the biggest setbacks to the A-10 program occurred in May 1975 (prior to DSARC III) when a JOTR was convened. The objectives of this review were to identify major cost issues, to reduce costs by eliminating marginal requirements, and to protect essential operational and support features of the aircraft.[29] Representatives from TAC, Air Force Systems Command (AFSC), Air Force Logistics Command (AFLC), and the A-10 SPO were present at this JOTR.[30] One IOT&E pilot and one AFSC test pilot also attended the meeting.

At the time of the meeting 571 sorties and 796.5 hours had been flown in the two prototypes.[31] Fewer sorties had been flown in the three available pre-production aircraft.

Even though the cost reduction candidates recommended by the JOTR were basically low technical risk, the important point was that the decisions made did not have the benefit of a large A-10 (versus YA-10) data base nor were these decisions based upon test flights in other than the "severe clear" weather conditions of the Mojave Desert.

Without a doubt the single purpose of the JOTR was to reduce costs. It certainly was not a forum for adding systems based upon mission requirements. The JOTR identified potential candidates for action which would reduce the cost of the A-10 by $20,000 per aircraft in 1970 dollars.[32] Potential candidates are shown in Appendix B.

As a result of JOTR recommendations, changes were approved and implemented in the ongoing production line. Two major changes impacting operations were the change from an automatic to a manual engine start system and the removal of the rotary speedbrake switch selector with a 40% detent. However, only the change in engine start systems has any bearing on this paper.

FOT&E PHASE I TESTING

SAS: In March 1977 the FOT&E Test Team re-opened the SAS issue because the present system was still not suitable for accurate weapons employment. The smooth control inputs required to place the pipper on target were simply not characteristic of a combat environment. The concensus of the FOT&E pilots was that an A-10 SAS must be compatible with combat weapon delivery tactics and not vice versa. TAC through SMO-10 supported this position.

Two FOT&E pilots were provided the opportunity to fly two different SAS configurations during September 1977 at Edwards AFB. One SAS incorporated a tilted gyro while the other SAS used two gyros which made it possible to dynamically measure changes in the aircraft's angle of attack. The tilted gyro was "optimized" for one airspeed/angle of attack. Any significant deviations from this pre-determined condition would cause a degradation in the ability of the system to dampen lateral oscillations. Of course the biggest difference in the two competing systems was cost. The more complicated SAS was estimated to cost $10 - $11 million more than the simplier tilted gyro SAS.[33]

A-10 SPO Engineering did not even want to test the dual gyro SAS for they felt it offered very little in the way of measurable improvement compared to the tilted gyro one. Fortunately TAC - through the insistence of SMO-10 and the Deputy for Requirements - demanded that both systems be evaluated. The FOT&E pilots flew each SAS only once on identical profiles. These sorties were flown on four successive days. The unanimous position of the two participants was that the more expensive SAS was operationally superior to the tilted gyro SAS. (Note: The pilot never knew which SAS was in his aircraft. Each pilot arrived at the same conclusion independent of the other.) Strafing results, however, did not confirm a marked difference in the competing systems. Based upon empirical data from four missions (i.e. strafe scores), the A-10 SPO proposed that TAC accept the less expensive, tilted gyro SAS.

TAC, to its credit, placed little emphasis on a four sortie evaluation of a new system and insisted that the A-10 had to have the better system. A milestone had been reached. Operational requirements had finally received more emphasis than cost. A great deal of credit for this change in attitude must go to the staff officers at TAC Headquarters. SMO-10 was the single TAC agency possessing the expertise to cause this change in attitude. The two FOT&E pilots had flown, evaluated, and reported their findings to TAC Headquarters. Only the using command could challenge the SPO based upon requirements.

Flare/Chaff: The JOTR decision implementing a manual ignition system was causing problems in the field. A pilot could inadvertently leave a switch in the ON position too long during the start cycle and ruin a starter valve.

The fact that engine start was not fool-proof coupled with the FOT&E recommendation to carry flares and chaff internally opened the door for a return to the automatic start system in a slightly different form. Of greater importance was the realization that the cost delta in returning to the automatic start system versus the cost delta for getting an automatic start system plus an internal flare/chaff capability was not too large.[34] Thus, the combination of a mistake due to a JOTR decision to save money coupled with a valid operational requirement for aircraft survivability in a high threat environment combined to produce the desired results.

Once flares and chaff were carried internally they were to be controlled by switches independent of the Armament Control Panel. A minor engineering modification was made to the automatic start system so that the two Manual Engine Start

Buttons (reference Figure 1 page 9) now became Flare and Chaff Dispense buttons.

It was now possible for the pilot to simultaneously arm his external ordnance and the GAU-8/A 30 millimeter gun, set his Flare/Chaff Programmer for either automatic or manual dispense, and proceed to the target area. All the necessary switches for firing/releasing ordnance or dispensing countermeasures were located on the control stick or the throttles. It was only a matter of selecting the proper button to obtain the desired result.

Maverick Slew/Track: All six aircraft assigned to the FOT&E Test Team had the slew-enable function disabled from the right throttle button. Low Ceiling/Low Visibility tests conducted during December 1976 at Ft. Lewis, Washington again confirmed that this was the preferred operation. IIR Maverick testing at Ft. Polk, Louisiana during February 1977 only served to reinforce the recommendation.

HUD: In June 1977 two FOT&E pilots flew a day/night HUD evaluation flight using circular polarizing filters for night operations. These filters eliminated the operational problems associated with using the HUD at night. To eliminate the objectionable dark band in the center of the HUD, engineers proposed using two uniform length combiner glasses with one reflective coating for each glass. Both proposals - night filters and uniform length combiner glasses - were judged to be operationally acceptable. The field-of-view problems due to safety specifications could not be surmounted without a comprehensive redesign of the cockpit. The advantages of such a redesign did not outweigh the disadvantages of cost, schedule disruptions, or A-10 commonality.

INS: Little progress was made during FOT&E to acquire an INS for the A-10. The problem was not further documentation of the requirement. Instead, the main obstacle was that the Department of the Air Force had gone on record for development of a standardized INS to meet its many mission requirements for different aircraft. Such an INS would reduce logistics support costs throughout the Air Force. This position delayed significantly the incorporation of an INS for the A-10 with a corresponding delay in achieving full combat capability.

Testing Summary

Even though FOT&E Phase I formally ended on 1 May 1977, it is apparent from the previous paragraphs that identified deficiencies were still being acted upon after the FOT&E Test Team was dissolved. (AFTEC was no longer in the official reporting channels after 1 May 1977.) From the author's perspective AFTEC did a highly credible job as an independent testing agency. More important, AFTEC was not afraid to admit its errors. A perfect example of this is when they reopened the SAS issue after initially accepting the inferior SAS flown during IOT&E Phase II. This oneincident shows their main concern was for an effective weapon system above all else.

Since this was the first major weapon system managed by AFTEC since its inception in late 1973, there was undoubtedly friction among AFTEC, TAC, and the A-10 SPO. But this adversary relationship seemed to work well for it created a third party to offset the traditional rivalries of the using command versus the developing command. Thus, AFTEC's objective reporting served its purpose by presenting facts in the form of test results. Decisionmakers at TAC and the SPO were working from a common data base to decide whether or not deficiencies could be corrected within given dollar constraints.

The ultimate proof of the IOT&E/FOT&E system is that all five systems discussed in this paper were approved for incorporation into the A-10 fleet. The process was lengthy - perhaps too lengthy - but it did work.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

The purpose of this paper was to examine the responsiveness of the Design-to-Cost procurement system to operator identified deficiencies. Five systems were discussed which, if approved for implementation, would give the A-10 a significant military capability in a Central European environment. The three sequential phases of Operational Testing and Evaluation (IOT&E Phase I, IOT&E Phase II, and FOT&E Phase I) were covered in some detail. The reason for delving into this historical data was to show that these five deficiencies had been noted early in testing. However, they were not acted upon in a timely manner. Timeliness was a problem due to the necessity to first identify a deficiency, document its proposed fix, test it, obtain go-ahead approval, solicit cost estimates from the contractor, and finally sign a binding contract. In the A-10 program the biggest time delay occured after the deficiency was identified and before it was approved for implementation into the A-10 fleet. Table 5 shows the responsiveness of DTC with respect to the five systems discussed in previous chapters.

Schedule and Cost Data

Table 5

A-10 Implementation Schedule[35]

System	Date Deficiency[36] Identified/Documented	Aircraft Production No.	Date of Delivery to USAF
Flare/Chaff	May 1976; IOT&E Phase II Test Report	152	November 1978
SAS	1. Oct-Nov 1974 2. Mar-Apr 1975 3. Mar 1977 AFTEC Msg	202	April 1979
HUD	Mar 1976 Deficiency Reports	202	April 1979
Slew/Track	May 1976; IOT&E Phase II Test Report	346	May 1980
INS	May 1976; IOT&E Phase II Test Report	418-426	November 1980 (or early 1981)

What Table 5 does not cover is the lengthy process required to retrofit the earlier production aircraft to the newer, improved configuration. All are depot level modifications with the exception of Maverick Slew/Track which can be performed in the field. (According to the A-10 SPO, the criteria used for depot modification is if the task takes longer than 25 maintenance man-hours for completion.[37]) The longer a fix is delayed, the greater the retrofit costs due to the larger number of aircraft involved. Life cycle costs also increase when systems are modified or changed relatively late in the production run. New inventories of spare parts must be acquired simultaneously with the phasing out of the obsolete inventory. These costs are not insignificant as the next table will illustrate.

Table 6

A-10 Cost Data for Five Selected Systems[38]
(all costs millions of dollars)

System	Non-recurring Costs	Production Costs	Retrofit Costs	Total
Flare/Chaff	5.978	50.155	21.736	77.869
SAS	.718	2.045	4.94	7.703
HUD	1.529	2.003	4.00	7.532
Slew/Track	.0616	-0-	.0775	.1391
INS	20.000	98.90	105.000	223.900
				317.1431

Disregarding non-recurring costs as sunk costs, it is possible to present a more graphic illustration of the magnitude of production and retrofit costs by using percentages. Table 7 portrays this data.

Table 7

Percentage of Investment

System	Production Costs	Retrofit Costs	
Flare/Chaff	64.41	27.91	
SAS	26.55	64.13	
HUD	26.59	53.11	
Slew/Track	-0-	55.72	
INS	44.15	46.88	
	48.26	42.79	Overall Average

Note that both Table 6 and Table 7 show no production costs for the Maverick Slew/Track modification. This is correct. The modification simply entails removing two wires from inside the right throttle quadrant to disable the Slew-Enable/Track function. Another way of looking at the same modification is that the Air Force is paying the contractor $139,100 to cut two wires and change the appropriate technical manuals. The production costs for the Flare/Chaff modification are relatively high compared to the other four systems. This is due to the requirement to manufacture cockpit control units and internal dispensing mechanisms.

Retrofit costs can be reduced if the system is changed earlier. When 42.79 percent of the money spent to solve pilot identified deficiencies is allocated to retrofit, the Design-to-Cost system is not being responsive nor is it holding down program costs. Amortizing the cost of these changes over a buy of 733 aircraft results in a unit cost increase of $432,469. Excluding the cost of the INS because it was not included in the original A-10 specifications, the amortized cost increase comes to $127,208 per aircraft. The expressed goal of DTC to prevent major cost increases by making cost equal to schedule and performance fails when viewed from the perspective of changes to meet operational requirements. Changes are needed in the DTC procurement process to satisfy valid requirements while preventing unnecessary expenditure of funds.

RECOMMENDATIONS

To assist the Air Force in procuring the best possible weapon system at the lowest price based upon the A-10 experience the following recommendations are offered. These are not in any order of priority. Instead, they represent a package which will increase communication among a systems program office, the using command, and the testing agency.

1. Eliminate the concept of a Joint Operational Technical Review. An ad hoc meeting to cut costs disrupts the normal channels which deal with such matters. During the JOTR test data will only exist from a relatively sterile environment and, as such, constitutes a very small sample size. Decisions can be made which will have far reaching consequences when the aircraft is deployed to different climatic regions. Furthermore, any meeting which focuses primarily on cost has bypassed the interrelationship that exists among cost, schedule, and performance. In the long run a JOTR hinders the achievement of DTC objectives.

The potential savings achieved from the JOTR was $20,000 per aircraft in 1970 year dollars. As already stated, the incorporation of a manual engine start system opened the door for obtaining the Flare/Chaff modification and a return to an automatic start system. The data from Table 6 shows that JOTR cost savings were exceeded on the Flare/Chaff modification alone. (Data from Table 6 is then year dollars. Costs are shown as fiscal year 1979 dollars.) The unit cost increase in then year dollars for the Flare/Chaff modification based on a programmed buy of 733 A-10s is $106,233. If only retrofit costs are counted then the unit cost increase for Flare/Chaff is $29,653.

2. Increase using command participation in the Joint Test Force at the earliest possible date. This proposal would require a staff officer from the using command to be an active Joint Test Force participant on a temporary duty basis. Preferably

this officer should be permitted to fly the aircraft in order to develop a first hand knowledge of its capabilities and limitations. The key point in this recommendation is that the officer is still assigned as a staff officer. Even though the using command places pilots on the Joint Test Force (and the IOT&E/FOT&E teams), the direct linkage is missing between testing at Edwards AFB and using command headquarters.

This is not to imply in any way that the officers who worked A-10 matters under the TAC Deputy for Requirements prior to the inception of SMO-10 were lax in their duties. Instead, it reflects a belief that indirect communications via the telephone or through official AFTEC reports tended to increase the time required for using command staff officers to begin working the problem at their level. I base this observation on one other example of staff officer familiarization in the A-10.

Toward the end of Phase II IOT&E at Edwards AFB a senior member of the A-10 SPO received a six ride checkout in the airplane. Members of the IOT&E test team did their very best to insure he would experience every objectionable feature of the aircraft. His statements at the conclusion of his checkout were: "Now I believe what you've been telling me. We've still got many problems to overcome." In my opinion, such a familiarization program for a using command staff officer would not adversely impact AFTEC's independence as long as this pilot did not fly dedicated IOT&E test sorties.

3. Continue the concept of a Systems Management Office at the using command headquarters. Immediately after the completion of IOT&E a minimum of one pilot and one senior

maintenance supervisor should be assigned to this office until the first wing achieves its Initial Operational Capability. The officer mentioned in the second recommendation would become a member of the SMO. A cadre of experience will exist to solve a wide gamut of problems. Most important, these personnel can argue their case based upon personal involvement/experience with the weapon system.

4. Periodically have a meeting with all pilots, staff officers from using command headquarters, AFTEC representatives, and senior SPO managers to discuss problem areas. The goal of this meeting is nothing more than to communicate directly with those personnel who can influence their subordinates to take action on a problem. Such meetings would increase responsiveness because the present process of submitting written Deficiency Reports is not timely. However, written reports would still be required for management action. In addition to increasing responsiveness, such corporate meetings would help clarify issues, obtain managerial level support for necessary changes, and establish priorities.

Summary

Total Package Procurement and Design-to-Cost both have one common characteristic - their forecast unit price has never been correct even after discounting for inflation. It is impossible to accurately predict a price that will remain firm throughout the exigiencies of the procurement process. Responsiveness to change can reduce the magnitude of cost growths. The importance of using the total operational knowledge of the pilots involved in testing cannot be overemphasized. There must exist a forum which permits pilots to express their opinions regarding additional requirements early in the testing phase. Such a forum might have eliminated many of the problems encountered by the A-10 in attaining a respectable degree of combat effectiveness. Additionally, money could have been saved due to earlier systems incorporation.

BIBLIOGRAPHY

Chapter I

1. Kozar, Paul M. "US Military Technology - The Soviet Perspective". Air University Review, Maxwell AFB, Al; Mar-Apr 1978; p. 68.

2. White, William D. US Tactical Airpower: Missions, Forces, and Costs. The Brookings Institution, Washington, D.C., 1974, p. 101.

3. Ibid, p. 2.

4. Atkinson, Thomas J. Sr. Design to Cost - Effective? USACGSC, April 1974, p. 1.

5. Proxmire, William Report From Wasteland. New York, Preager, 1970, p. 5.

6. Design to Cost - Effective? p. 6.

7. Rustia, William J. Design to Cost: From Buzzword to Necessity. Defense Systems Management College, Ft. Belvoir, Va., Aug 1977, p 1.

8. Ibid, p 1-3.

9. Design to Cost - Effective? p 7.

Chapter II

10. Six A-10's flew 66 sorties in three days (daylight hours only). Pilot fatigue was the limiting factor.
Brown, David A. "A-10 Pilots Stress Navaid Requirement", AW&ST, 19 Sep 1977, p 52.

11. Ibid, p 52-53.

12. Senate Armed Services Committee Special Subcommittee on Close Air Support., 92nd Congress, US Government Printing Office, 22 Oct 1971, p 48.

Chapter III

13. Svetlich, William G. The Systems Acquisition Process in the Department of Defense and its Limitations., National Defense University, Ft. Leslie J. McNair, Washington D.C., June 1978, p III-1 through III-3.

14. Ibid, p III-5.

15. "Air Force Test and Evaluation Center", Air Force Magazine, March 1977, p 101.

16. A-10 AF DT&E Test Plan Phase II & III DT&E/IOT&E, Air Force Systems Command, Air Force Flight Test Center, Edwards AFB, California; October 1974, p. 5.

17. A-10 IOT&E Phase I Final Report. Air Force Test And Evaluation Center, Kirtland AFB, N. Mexico; November 1975, p 1.

18. A-10 IOT&E Phase II Final Report. Air Force Test and Evaluation Center, Kirtland AFB, N. Mexico; May 1976, p i.

19. Prototype To Production: A-10A Aircraft System Improvements. Fairchild Republic Co., Farmingdale, N. Y.; 15 March 1974, p 2-1.

20. Preliminary Evaluation of A-10AHandling Qualities. Air Force Flight Test Center TR-76-1, Edwards AFB, California; January 1976, p 19.

21.. A-10 IOT&E Phase II Final Report, p 46.

22. Ibid, p 47.

23. Ibid, p 70.

24. Ibid, p 72.

25. Ibid, p 110.

26. Odgers, Peter W. Colonel, USAF Design to Cost, The A-X/A-10 Experience. Professional Study # 5370,,Air University, Maxwell AFB, Alabama; April 1974, p 11.

27. PrototypeTo Production: A-10A Aircraft Systems Improvements. p 8-1.

Chapter IV

28. A-10 Test Plan: FOT&E Phase I. Hqs AFTEC, Kirtland AFB, N. Mexico; June 1976, p 2.

29. TAC, AFLC, AFSC Joint Operational Technical Review Letter dated 13 May 1975.

30. Telecon with Lt Col Caughell, A-10 SPO, 15 March 1979.

31. A-10 IOT&E Phase I Final Report. Air Force Test and Evaluation Center, Kirtland AFB, N. Mexico; November 1975, p i.

32. TAC, AFLC, AFSC, Joint Operational Technical Review Letter dated 13 May 1975.

33. Personal notes dated 12 May 1977. Memo for Record submitted to 35th TFW/DO. I attended this meeting.

34. Telecon with Lt Col Caughell, A-10 SPO, 15 March 1979.

Chapter V

35. Telecon with Major Butt, TAC/DRFG, February 1979. Reconfirmed with Major Finch, A-10 SPO, May 1979.

36. The dates derived for this column are taken from the IOT&E Phase II Test Report dated May 1976 and Deficiency Reports submitted by members of the A-10 Joint Test Force. The actual dates that the deficiency was submitted to program managers occured before the May 1976 publication date. Note that there are three dates given for the SAS. These correspond to: (1) the first optimization of the SAS on the YA-10 prototype, (2) the discovery of the degraded SAS on the pre-production A-10A which led to the AFPE conducted between 30 Oct 1975 and 10 Nov 1975, and (3) the reopening of the SAS issue by the FOT&E team because the SAS accepted during the AFPE was not compatible with tactical maneuvers required for accurate weapons delivery. With the single exception of the third SAS iteration, all of these deficiencies were well known prior to the DSARC III meeting scheduled in late 1975.

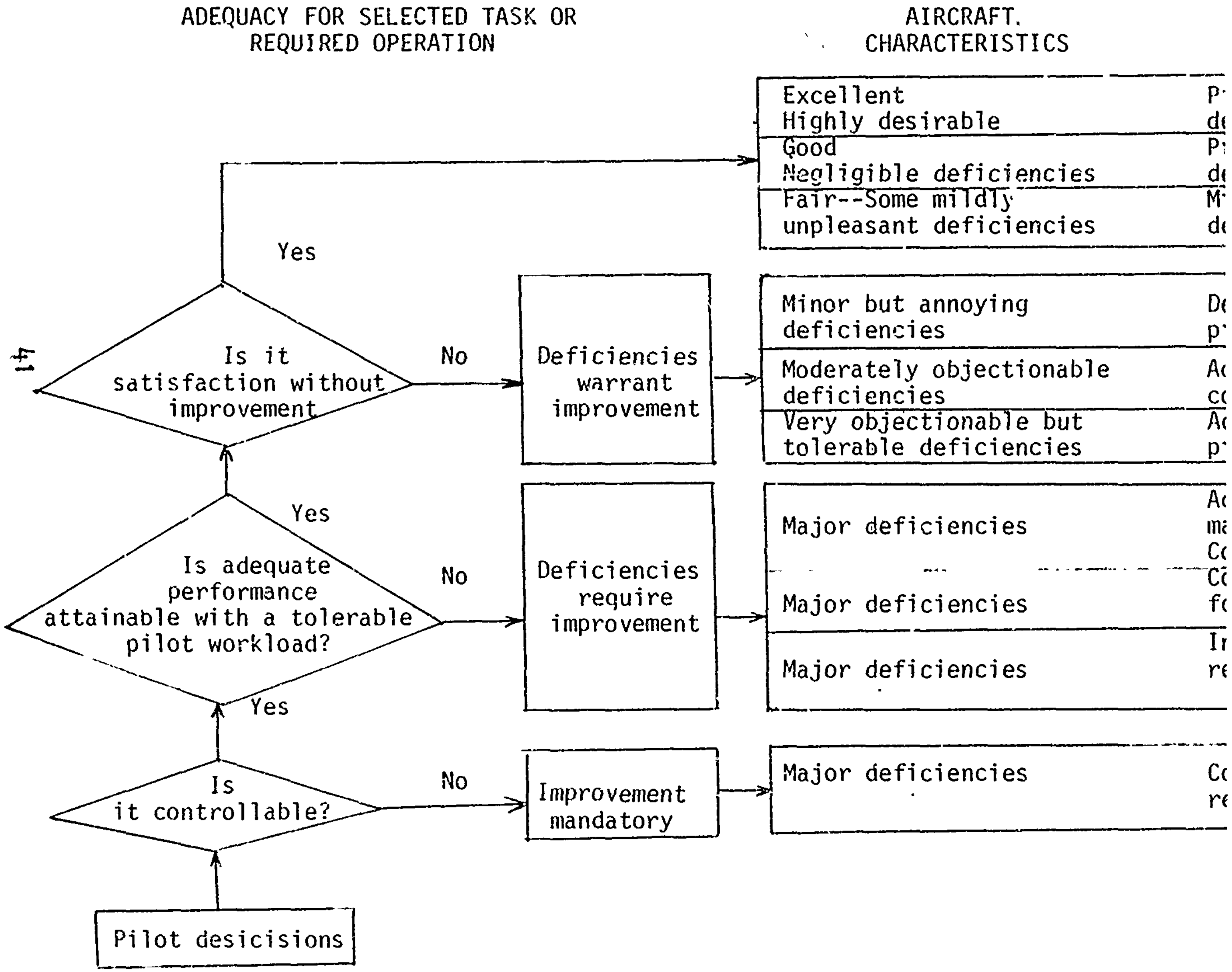
37. Telecon with Major Finch, A-10 SPO, May 1979.

38. Data received from Lt Colonel Caughell, A-10 SPO, April 1979.

APPENDIX A

COOPER - HARPER

HANDLING QUALITIES RATING SC



Appendix B

JOTR Recommended Changes

	Airframe #	Changes
1.	3	Tail cone
2.	23	Eliminate Group B of X-band beacon after #250
3.	24	Machining of bathtub
4.	34	Simplify oil fill
5.	37	Simplify starter switch
6.	49	Eliminate auto antenna select
7.	60	Eliminate speed brake indicator
8.	86	Eliminate sway brace fairings
9.	17-2	Eight position intervalometer
10.	17-4	Eliminate push-to-jettison switch
11.	17-10	Delete CBU-38 adapter
12.	17-3	Eliminate stores from stations 1 and 11
13.	17-9	Eliminate store from station 6
14.	100-4	Simplify UARRSI door
15.	103-2	APU HYD PUMP acceptance test
16.	104-2	Change location of AP indicator on CSD
17.	104-3,4	Change manufacturing and eliminate lightening holes
18.	107-4	Eliminate dual mount on air turbine starter valve
19.	108-4	Remove fireproof "Doghouse" from APU
20.	110B	Eliminate redundancy in SAS
21.	112C	Bolt-on cap to antiskid system
22.	114-1	TV monitor test
23.	118	Selectively eliminate shot peening
24.	119	Changes to castings and forgings
25.	89	Simplify speed brake